REMARKS

Amended claims 9, 17, and 19, and claims 1-8, 11-16, 18, and 24 are currently pending. Claims 1, 2, 7-9, 11, 12, 16-18, and 22-24 stand rejected and claims 3-6, 10, 13-15, and 19-21 stand objected to.

Figure 1 stands objected to for failing to comply with 37 CFR 1.84(p)(5) for omitting a reference sign. A proposed drawing correction accompanies this filing which includes the label "10." No new matter has been added.

Claim 17 stands objected to for failing to comply with a formality. To correct the obvious stenographical error the claim has been amended changing "161" to "16." Claims 17 and 20 have been amended to correct the obvious stenographical errors changing "when" to "wherein." Claim 9 has been amended to correct the stenographical errors changing "pixels'" to "pixel's." No new matter has been added by any of these amendments.

The "Cross Reference to Related Applications" section of the specification has been amended to properly reflect the filing date of the provisional application ("April 23, 1999"). No new matter has been added.

Claims 1, 2, 7-9, 11, 12, 16, 18, and 22-24 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Pain et al. (U.S. Pat. No. 6,326, 230) (hereafter "Pain") in view of Iida et al. (U.S. Pat. No. 6,215,139) (hereafter, "Iida").

The present invention relates to active pixel sensors with undesirable fixed pattern noise associated with the use of transfer gates to transfer charge packets from one region of the sensor to another. The present invention helps reduce undesirable fixed pattern noise by passing the charge accumulated in a photoactive region of a cell

through a second active region before the charge is transferred to either a sense node or a power supply node of the pixel. (Spec. p. 2, l. 6 - p. 3, ll. 20).

Claim 1 recites, inter alia, a method of operating a pixel comprising "transferring charge, accumulated in a photoactive region of the pixel during a first period, through a second active region of the pixel to a power supply node; and transferring charge, accumulated in the photoactive region during a second period, through the second active region to a sense node in the pixel."

Pain seeks to address image distortion caused by non-simultaneous exposure of pixels as well as image distortion and excess noise caused by floating diffusion regions collecting photocharges after a photogate is turned off. (Pain, Col. 2, ll. 12-25). Iida recognizes the opposite conductivity types of a semiconductor substrate and a photodiode and that the impurity concentrations of each will offset each other. Iida seeks to address the offset and provide an image sensor with reduced sized pixel without deteriorating the dark-current characteristics of the photodiode. (Iida, Col. 2, ll. 14-42).

Neither Pain nor Iida, whether considered individually or in combination, teaches or suggests "transferring charge, accumulated in a photoactive region of the pixel during a first period, through a second active region of the pixel to a power supply node; and transferring charge, accumulated in the photoactive region during a second period, through the second active region to a sense node in the pixel." The Office Action recognizes that "Pain does not explicitly state that the charge is transferred intermediately through a second active region for each of the two periods." Iida is similarly deficient.

In addition, absent the claimed invention, there is no motivation in Pain or Iida to combine their teachings in the manner suggested in the Office Action, particularly where neither addresses the fixed pattern noise problem addressed by the claimed invention.

For the foregoing reasons, withdrawal of the rejection of claim 1 is respectfully requested.

Claim 2 depends from claim 1, and incorporates, directly and indirectly, all the limitations thereof. Therefore, withdrawal of the rejection of that claim is respectfully requested.

Claim 7 recites, inter alia, a method of operating an image sensor comprising an array of pixels, the method comprising "transferring, for each pixel, charge accumulated during a first period from a photoactive region of the pixel to a power supply node of the pixel through a second active region of the pixel; allowing photocharge to accumulate in the photoactive region of each pixel during a second period; and transferring the charge accumulated in the photoactive region of each pixel during the second period to a respective sense node in the pixel through the second active region of the pixel, wherein the latter transfer occurs substantially simultaneously for all the pixels."

Neither Pain nor Iida, whether considered individually or in combination, teaches or suggests "transferring ...charge accumulated during a first period ...to a power supply node of the pixel through a second active region of the pixel...transferring the charge accumulated ...during the second period to a respective sense node in the pixel through the second active region of the pixel...." The Office Action recognizes that "Pain does not explicitly state that the charge is transferred

intermediately through a second active region for each of the two periods." Iida is similarly deficient.

In addition, absent the claimed invention, there is no motivation in Pain or Iida to combine their teachings in the manner suggested in the Office Action, particularly where neither addresses the fixed pattern noise problem addressed by the claimed invention.

For the foregoing reasons, withdrawal of the rejection of claim 7 is respectfully requested.

Claims 8 and 9 depend from claim 7, and incorporate, directly and indirectly, all the limitations thereof. Therefore, withdrawal of the rejection of these claims is respectfully requested.

Claim 11 recites, inter alia, an image sensor comprising "a plurality of pixels formed in a semiconductor substrate, wherein each pixel includes: a photoactive region in the substrate; and a second active region in the substrate separate from the photoactive region; a sense node; and a power supply node; the image sensor further including a controller arranged to cause control signals to be provided to each pixel to cause the pixel to: transfer charge accumulated, in the pixel's photoactive region during a first period, to the power supply node through the pixel's second active region; and transfer charge, accumulated in the pixel's photoactive region during a second period, to the pixel's sense node through the pixel's second active region."

Neither Pain nor Iida, whether considered individually or in combination, teaches or suggests "...the pixel to: transfer charge accumulated, in the pixel's photoactive region during a first period, to the power supply node through the pixel's second active region; and transfer charge, accumulated in the pixel's photoactive region

during a second period, to the pixel's sense node through the pixel's second active region." The Office Action recognizes that "Pain does not explicitly state that the charge is transferred intermediately through a second active region for each of the two periods." Iida is similarly deficient.

In addition, absent the claimed invention, there is no motivation in Pain or Iida to combine their teachings in the manner suggested in the Office Action, particularly where neither addresses the fixed pattern noise problem addressed by the claimed invention.

For the foregoing reasons, withdrawal of the rejection of claim 11 is respectfully requested.

Claim 12 depends from claim 11, and incorporates, directly and indirectly, all the limitations thereof. Therefore, withdrawal of the rejection of this claim is respectfully requested.

Claim 16 recites, inter alia, an image sensor comprising: "a plurality of pixels formed in a semiconductor substrate, wherein each pixel includes: a photoactive region in the substrate; and a second active region in the substrate separate from the photoactive region; a sense node; and a power supply node; the image sensor further including a controller arranged to cause control signals to be provided to each pixel so that the pixel can operate in any one of at least four modes including a first mode in which photocharge generated in the photoactive region is accumulated in the pixel's photoactive region; a second mode in which charge is transferred from the pixel's photoactive region to the pixel's second active region; a third mode in which charge is transferred from the pixel's second active region to the pixel's power supply node; and

a fourth mode in which charge is transferred from the pixel's second active region to the pixel's sense node."

Neither Pain nor Iida, whether considered individually or in combination, teaches or suggests "...a first mode in which photocharge ...is accumulated in the pixel's photoactive region; a second mode in which charge is transferred ...to the pixel's second active region; a third mode in which charge is transferred from the pixel's second active region to the pixel's power supply node; and a fourth mode in which charge is transferred from the pixel's second active region to the pixel's sense node." The Office Action recognizes that "Pain fails to teach a mode (i.e. second mode) in which charge is transferred from the pixel's photoactive region to the pixel's second active region." Iida is similarly deficient.

In addition, absent the claimed invention, there is no motivation in Pain or Iida to combine their teachings in the manner suggested in the Office Action, particularly where neither addresses the fixed pattern noise problem addressed by the claimed invention.

For the foregoing reasons, withdrawal of the rejection of claim 16 is respectfully requested.

Claims 18 and 22-24 depend from claim 16, and incorporate, directly and indirectly, all the limitations thereof. Therefore, withdrawal of the rejection of these claims is respectfully requested.

Claims 3-6, 10, 13-15, and 19-21 stand objected to. However, the claims are allowable for at least for the reasons provided above.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

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Respectfully submitted,

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